We claim:

1. An isolated nucleic acid sequence which codes for polypeptides having Δ-4-desaturase activity, selected from the group:

   a) of a nucleic acid sequence having the sequence depicted in SEQ ID NO: 1,

   b) nucleic acid sequences which, as a result of the degeneracy of the genetic code, can be derived from the coding sequence comprised in SEQ ID NO: 1, or

   c) derivates of the nucleic acid sequence depicted in SEQ ID NO: 1, which code for polypeptides having the amino acid sequences depicted in SEQ ID NO: 2 and have at least 40% homology at the amino acid level with SEQ ID NO: 2 and have a Δ-4-desaturase activity.

2. The isolated nucleic acid sequence according to claim 1, where the sequence is derived from a plant.

3. The isolated nucleic acid sequence according to claim 1 or 2, where the sequence is derived from the class of Euglenophyceae.

4. An amino acid sequence which is encoded by an isolated nucleic acid sequence according to any of claims 1 to 3.

5. A gene construct comprising an isolated nucleic acid according to any of claims 1 to 3, where the nucleic acid is functionally connected to one or more regulatory signals.

6. The gene construct according to claim 5, wherein the nucleic acid construct comprises additional biosynthesis genes of fatty acid or lipid metabolism selected from the group of acyl-CoA dehydrogenase(s), acyl-ACP [= acyl carrier protein] desaturase(s), acyl–ACP thioesterase(s), fatty acid acyltransferase(s), acyl-CoA:lysophospholipid acyltransferase(s), fatty acid synthase(s), fatty acid hydroxylase(s), acetyl-coenzyme A carboxylase(s), acyl–coenzyme A oxidase(s), fatty acid desaturase(s), fatty acid acetylenases, lipoxygenases, triacylglycerol lipases, allene oxide synthases, hydroperoxide lyases or fatty acid elongase(s).

7. The gene construct according to claim 5 or 6, wherein the nucleic acid construct comprises additional biosynthesis genes of fatty acid or lipid metabolism selected from the group of Δ-4-desaturase, Δ-5-desaturase, Δ-6-desaturase, Δ-8-desaturase, Δ-9-desaturase, Δ-12-desaturase, Δ-5-elongase, Δ-6-elongase or Δ-9-elongase.

8. A vector comprising a nucleic acid according to claims 1 to 3 or a gene construct according to claim 5.

9. A transgenic nonhuman organism comprising at least one nucleic acid according to claims 1 to 3, one gene construct according to claim 5 or one vector according to claim 8.

10. The transgenic nonhuman organism according to claim 8, where the organism is a microorganism, a nonhuman animal or a plant.

11. The transgenic nonhuman organism according to claim 9 or 10, where the organism is a plant.

12. A process for producing polyunsaturated fatty acids, where the process comprises the culturing of a transgenic organism which comprises a nucleic acid according to claims 1 to 3, a gene construct according to claim 5 or a vector according to claim 8 encoding a Δ-4-desaturase which specifically desaturates ω-3-fatty acids, and where polyunsaturated fatty acids which have an increased content of ω-3-fatty acids are formed in the organism through the activity of the Δ-4-desaturase.

13. The process according to claim 12, where docosahexaenoic acid is produced in the process.

14. The process according to claim 12 or 13, where the polyunsaturated fatty acid molecules are isolated from the organism in the form of an oil, lipid or a free fatty acid.

15. The process according to any of claims 12 to 14, where the organism is a microorganism, a nonhuman animal or a plant.

16. The process according to any of claims 12 to 15, where the organism is a transgenic plant.

17. An oil, lipids or fatty acids or a fraction thereof produced by the process according to any of claims 12 to 16.

18. An oil, lipid or fatty acid composition which comprises PUFAs produced by a process according to any of claims 12 to 16 and is derived from transgenic plants.

19. The use of oil, lipids or fatty acids according to claim 17 or oil, lipid or fatty acid composition according to claim 18 in animal feed, human foods, cosmetics or pharmaceuticals.